USING WEB 2.0 TOOLS TO FACILITATE KNOWLEDGE TRANSFER IN COMPLEX ORGANISATIONAL ENVIRONMENTS - A PRIMER

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Summary: An often neglected but well recognised aspect of successful engineering asset management is the achievement of co-operation and collaboration between various occupational, functional and hierarchical levels present within complex technical environments. Engineering and technical contexts have been well documented for the presence of highly cohesive groups based around around functional or role orientations. However while highly cohesive groups are potentially advantageous they are also often correlated with the emergence of knowledge and information silos based around those same functional or occupational clusters. Improved collaboration and co-operation between groups has been demonstrated to result in a number of positive outcomes at an individual, group and organisational level. Example outcomes include an increased capacity for problem solving, improved responsiveness and adaptation to organisational crises, higher morale and an increased ability to leverage workforce capability. However, an essential challenge for organisations wishing to overcome informational silos is to implement mechanisms that facilitate, encourage and sustain interactions between otherwise disconnected groups. This paper reviews the ability of Web 2.0 technologies and mobile computing devices to facilitate and encourage knowledge sharing between "silo'd" groups. Commonly available tools such as Facebook, Twitter, Blogs, Wiki's and others will be reviewed in relation to their applicability, functionality and ease-of-use by engineering and technical personnel. The paper also documents three case examples of engineering organisations that have successfully employed Web 2.0 to achieve superior knowledge management. With a number of clear recommendations the paper is an essential starting point for any organization looking at the use of new generation technologies for achieving the significant outcomes associated with knowledge transfer.

1 INTRODUCTION

The recent media storm surrounding the role played by the on-line social networking application Twitter in the Iranian election highlights the increasingly prevalent role played by such technologies in society. Rather than remaining the preserve of tech-savy teens social media tools such as Facebook, Myspace and blogs are becoming increasingly prevalent for a significant proportion of the population. Organisations have also been impacted by the emergence of these Web 2.0 technologies, however for the most part a key focus has been around employee productivity and deviance associated with the usage of these sites [1]. However the "Twitter revolution" also highlights the continued lack of understanding of what these tools are, how they are used and more importantly from a managerial perspective, how organisations may use them in order to achieve positive organisational outcomes.

This paper aims to review the ability of Web 2.0 technologies and mobile computing devices to facilitate and encourage knowledge sharing within organisations. Commonly available tools such as Facebook, Twitter, Blogs, Wiki's and others examples will be reviewed in relation to their applicability and functionality to organizational outcomes. The use of these tools is situated in a knowledge management context, demonstrating that effective use of these tools can help improve the extraction and utilisation of tacit knowledge within organisations - particularly in those where the potential for information silos is high (e.g. where strong departmental and functional boundaries exist that may hinder co-operation and collaboration). In order to do this the use of these tools is considered in the context of complex engineering and industrial organisations such as nuclear reactors, large scale manufacturing firms, public utilities. Engineering and industrial contexts have been well documented for the presence of highly cohesive groups based around around functional or role orientations [2]. However while highly cohesive groups are potentially advantageous they are also often correlated with the emergence of knowledge and information silos based around those same functional or occupational clusters. Therefore an essential challenge for organisations wishing to overcome informational silos is to implement mechanisms that facilitate, encourage and sustain interactions between otherwise disconnected groups. It is intended that this paper be an essential starting point for any complex organization looking at the use of new generation technologies for achieving the significant outcomes associated with knowledge transfer within these types of contexts.

2 TRIBALISM, KNOWLEDGE SHARING AND ENTERPRISE 2.0 APPLICATIONS

One of the most defining aspects of an engineering and industrial workplace is not its technology, but the nature of its workforce. Such workplaces are typified by a number of cohesive groups, drawn together by occupational, professional, contractual and role based alliances. A preliminary stock-take of any engineering and industrial workplace will identify a multitude of potential "tribes" in existence at any one time. Individuals may associate with projects, trades, departments, function within the organisation - increasing the difficulties associated with knowledge sharing and co-ordination between these groups .

Some advantages of belonging to a cohesive group have been identified as driving co-operative behaviour within the group [3] subjective well being, happiness and positive affect in general [4]. Further, Cabrera and Cabrera [5] argue the benefits to an individual for knowledge sharing include: gaining expert status; receiving public praise by management; expected reciprocity for providing information; and personal satisfaction from contributing to the professional development of others. In a broader setting highly cohesive groups also encourage the transfer of tacit knowledge within themselves, display higher overall levels of citizenship behaviour and increased levels social support [3]. Conversely, a lack of belonging has been found to lead to negative consequences including loneliness [6], decreased pain sensitivity, emotional distress, impaired intelligent thought and poor self regulation [7].

At an organizational level the effects of highly cohesive groups are more variable. While higher levels of cohesion are likely to result in higher retention, morale and productivity, tribalism can also have significant negative effects such as the emergence of information silos and the promotion of inter-group conflict. Recent research has identified the critical nature of co-operation, collaboration and information management in relation to the effective management of engineering assets [8]. Complex engineering environments require significant levels of interaction between various groups and levels within to ensure asset safety, utilisation and cost effectiveness [9]. Unfortunately the presence of highly cohesive groups centered around their respective occupational or functional "tribes" may prevent or at best hinder, free and open co-operation between them. Van Maanen and Barley [10] explain that individuals learn a set of codes when they become a member of an occupational community and these codes can form the basis of meaningful interpretations of objects, events and persons. For people from different "tribes", interpretations of the same events, objects or people may differ due to their different sets of codes. Consequently having different understandings of events may hinder knowledge transfer and thus understandings might need to change before knowledge can be passed on effectively.

Wegner [11] however asserts that participation between tribal groups is essential for broader organizational learning. Knowledge sharing between tribes allows for understanding of other groups' perspectives and operational conditions, leading to improved problem solving and performance [12]. Therefore the purpose of this paper is not to look at ways to disperse or weaken the effect of tribal membership, but examine the ability of Enterprise 2.0 applications to help leverage the localised knowledge generated within tribal settings into broader organisational outcomes by providing a mechanism for knowledge sharing and extraction when required. We review the emerging technologies of Enterprise 2.0 or Web 2.0 applications in relation to their applicability to act as mechanisms to encourage knowledge transfer between engineering tribes. We examine the utility of such applications, their suitability for engineering asset workplaces and the issues surrounding their adoption, implementation and use. A draft set of recommendations are put forward for those wishing to consider the application of Enterprise 2.0 tools within their organization.

3 KM AND ENTERPRISE 2.0 TOOLS AS BOUNDARY SPANNING OBJECTS

Enterprise 2.0 and Web 2.0 applications (collectively known as social media technologies) represent an evolution in the way that internet based applications and software are designed, used and interpreted by users. Original internet applications represented a typically passive, uni-directional flow of information to users. The way in which content was chosen, presented and deployed was driven by the developer, and resulted in a sub-optimal user experience. In contrast, web 2.0 applications are heavily underpinned user-centred design principles. Web 2.0 applications typically allow a high degree of customisation, allow users to quickly and easily add and remove content, contribute to the application's content, and facilitating social networking opportunities [13]. An essential aspect of Web 2.0 applications is their focus on the transfer of information in multiple formats (text, pictorial, video, audio) establishing a web of connections to sub-applications and provide an instantaneous feedback loop to users [14]. The developer to some degree surrenders control of the content by offering a flexible application architecture that provides structure, but is adaptable enough to change according to user's requirements [13]. Popular examples of Web 2.0 applications include FACEBOOK, MYSPACE, TWITTER and other generic tools such as blogs and wikki's. Enterprise 2.0 tools all share the fundamental architectural, design and functional aspects of Web 2.0 tools but typically refer to those used within an organisational environment. This paper explores the potential of Enterprise 2.0 tools to act as boundary spanning mechanisms, and the ways in which they may utilised by organisations for knowledge transfer.

Bechky (2003) identified that tangible objects, such as machinery and products provided a common ground which could facilitate shared understanding and effective knowledge transfer between workers represented by different

occupational communities. These objects which create a common ground between tribes have been referred to as boundary objects. Star and Griesemer [16] describe boundary objects as abstract or concrete objects which intersect several social groups and provide information to each group. A boundary object may have different meanings to each group however its structure is consistent enough that it is recognisable across groups. Boundary objects play an important role when separate groups interact. Star and Griesemer [16] identified a number of boundary objects intersecting three groups (sponsors, theorists and amateurs) working in the natural history field including specimens, field notes and maps. Carlisle [17] highlighted the use of assembly drawings acting as boundary objects between designers and manufacturers in product development. He demonstrated that useful boundary objects provide the opportunity for shared language which provides a concrete way of learning and describing dependencies and differences between groups and affords opportunities for people to develop a collective understanding of the issue(s) at hand. Therefore the key is to develop or identify a common ground, a mechanism that links groups and provides a neutral space to begin defining the scope and nature of the issue, as well as allowing a non-threatening way of sharing and exchanging ideas, knowledge and suggestions. It is suggested that Enterprise 2.0 technologies are able to be used as boundary spanners between isolated groups.

3.1 Social Media Software and Organisational Applications

A recent report produced for the US Department of Defence provides a useful framework to consider the functionality of Web 2.0 applications in an enterprise context. Drapeau and Wells [18] consider four key desired outcomes or uses of social media technologies (SMT), these are listed below:

Inward Sharing: Sharing information within agencies, departments, divisions or any component of the organisation. This function is this most obvious to consider when thinking of using social media software in an knowledge management application. Drapeau and Wells [18] make an essential observation in relation to the value of *Inward Sharing* applications is that they allow a constant stream of user defined data, allowing users to develop an "*ambient awareness of other's behaviour*" as well as increasing the potential for the serendipitous discovery of knowledge from previously unconnected sources. This appears particularly relevant in engineering asset intensive organisations populated by groups of technical specialists highly knowledgeable in their own domain, but perhaps unaware of potentially valuable developments in others.

Outward Sharing: Refers to the sharing of information of outside of organisational boundaries, but with those organisations and institutions that have an existing relationship with the organisation. Relevant examples may include contracting organisations, suppliers, customers and government. This function would appear particularly relevant to engineering asset intensive organisations due to the complex nature of their work environments and the multitude of stake-holders that have an interest in its operation. SMT applications have the capacity to allow interaction between disparate groups regardless of their affiliation or geographical dispersion. There are a number of advantages with the use of SMTs, particularly in situations where there is heavy use of contracting or outsourcing. SMTs represent a mechanism whereby contractors can develop and maintain relationships with organisations they may only have periodic contact with, and exchange knowledge beyond the exact terms of the service agreement, offering an additional value proposition for both parties. The use of SMTs may also assist in increasing the embeddedness of employees and their families, as it may be used to broaden and strengthen the peripheral social network of employee's families. An often disparaged aspect of SMTs in an enterprise setting, the powerful social aspect of SMTs could facilitate employee family members to develop social relationships that otherwise may not emerge due to the demands and challenges of modern family life.

Inbound Sharing: A function whereby organisations receive unsolicited communications from groups outside the established frequent interactions of an organisation. SMTs provide a mechanism for potentially disenfranchised groups impacted by an organisation's actions to raise concerns, provide suggestions, uncover unknown knowledge and yield information or knowledge from other fields and sources of data previously un-accessed. A key element of this function is the ability of SMT to provide real-time, immediate feedback to issues faced by the organisation, allowing rapid responses. For example, environmental groups may provide feedback on the environmental impact of asset operations and may stimulate a discussion as to ways in which the organisation may act to rectify the situation.

Outbound Sharing: The purpose of this function is to communicate to groups not connected to the organization by formal communication channels. Typically this has been the key function adopted by organizations and this technology. While organizations have adopted Web 2.0 tools in sophisticated marketing campaigns few have explored fully the utility of Web 2.0 applications in the remaining three functions [19]. Selected case examples are reviewed at the end of the paper to demonstrate the way in which various engineering organizations have adopted social media software to its fullest extent, adopting all four functions outlined above.

In summary, while social media applications have received widespread acceptance in social settings organisations have been slower to incorporate such technologies into their organisational [19]. A key aim of this paper was to review some of the more popular SMT applications and consider their use in a commercial environment. In particular we were interested to examine the functionality of these applications in relation to the facilitation of

knowledge management and transfer in complex, dynamic engineering environments typified by the presence of silo'd tribes, particularly "Inward sharing" and "Outward Sharing" applications. Below is a description of the major tools, core functionality and possible uses within complex industrial organisations. Using Drapeau and Wells' [18] framework we have audited a selection of the most established and popular SMTs, outlining their core functionality, focusing on potential uses for the first two categories. These have been tabulated and presented in Table 1.0 below.

Table 1

FACEBOOK & MYSPACE	
The dominant publicly available social networking site/community, Facebook currently has over 175m active users (Mones, www.livingstonebuzz.com). The first choice of most users Facebook is typically known for its ability to help users build and maintain on-line social relationships. However multiple Facebook 'applications' are available for different uses. These type of applications allow users to post content to a defined area and allow users to share that content to others within their defined network. Highly flexible, users within a network can comment on posted content, initiate discussions, initiate contact and constantly update their "status", broadcasting their current activities, state of mind or any other random thoughts. Recent discussions have highlighted Facebook's aim to change the way in which data is shared and used in the internet as compared to the "Google" model (Vogelstein, 2009). In an enterprise knowledge exchange context a tool such as Facebook can have the following potential uses.	
Inward	• Establish relationships with colleagues across a firm • Emergent "digital communities of practice" can develop or can be created • Greater capacity for problem sharing/solution generation • Ongoing disclosure and dialogue with colleagues regardless of location • Expertise sourcing and sharing • High degree of user validity and acceptance • Increased productivity from improved searching capability and rapid knowledge exchange
Outward	• Build relationships with colleagues external to firm • Possible sector-specific activities • Communication development, networking, discussion forums, build relationships • Publicity/marketing (little support for this although is used for it) • Prospect customers / clients • create organisational / project profiles (popular amongst small and not-for-profit organisations) • Employer of choice marketing
Twitter	
Micro-blogging site allowing 140-character messages (tweets). 3rd most visited site, hailed as greatest rising market in SMT applications. Twitter allows users to post "real-time" updates of their progress, current activities and allows high degrees of user visibility. User "followers" are able to respond to tweets - e.g. a response to a query, statement of problem, request for advice. In an enterprise knowledge exchange context tools such as Twitter maybe useful for employees to rapidly source expertise, post progress updates and rapidly disseminate information "news-flashes". Twitter can be a useful tool to draw in others that may be of use or knowledgeable in you field, but are only required on a periodic, short term basis (e.g. quick query, tacit knowledge extraction)	
Inward	• Flagging of emergent / "breaking news" issues • Promotes awareness and facilitates rapid responses to issues • Micro-communities (potential for growth in specialized closed groups) • work-streaming ('private accounts) • Micro-blogging (e.g. Sound bites from projects - knowledge transfer and dissemination) • Sharing links to items of interest • Reinforcing current network contacts • Promoting specific content • Influencing your network • Group and project communications

Outward	• Establishment of micro-communities • Micro-blogging (e.g. Sound bites from conferences, rapid knowledge transfer) • Build relationships within the community • Sharing links to items of interest • Networking for new contacts • Reinforcing current network contacts • Promoting specific content • Influencing your network
Linked-in	
Linked-In was the application that initiated Morgan Stanley's widespread SMT adoption and is an example of a 'professional' social network service with a strong focus on establishing and maintaining networks associated with vocational and employment related activities. Linked-In is primarily a professional-oriented social networking site founded in December 2002 and launched in May 2003. As of May 2009, it had more than 40 million registered users, spanning 170 industries. As highlighted by Morgan Stanley's example Linked-In demonstrates the "serious" side of social software and the valuable organisational and productivity related outcomes that can be associated with its use	
Inward	• Gain new insights from discussions with like-minded professionals in private group settings • Linked-in Answers feature - allows users to ask question for community to answer • Contacts can be sourced from secondary network connections (friends of friends) • Expertise sourcing • reinforcing current network contacts • promoting specific content • influencing your network
Outward	
Wikis	
A wiki is a website that allows anyone to edit the content of the site and add content as on an internet forum - *serview* software allows users to freely create and edit web page content using any web browser Shared knowledge and collaborative authoring. A wiki page is usually created around a specific content area or knowledge domain. Users can track the longitudinal changes to the document creating a high degree of accountability and transparency.	
Inward	• Share ideas/ team collaboration/knowledge collection • Wiki intranets • Google blogger uses wikis for collaborative authoring of documents and as a forum for proposing ideas for new projects • Internal brainstorming • Create meeting agendas, post training videos for new hires • Creating presentations
Outward	
Google Apps (Google Docs & Google Groups)	
Google offers two applications able to be used in an Enterprise 2.0 context. Google docs allow users to create word-processing, spreadsheet and presentation applications that are web-hosted and can be remotely accessed remotely by any authorized user. Documents can be edited simultaneously by multiple users. Google groups allows an extension of Google Docs into a MS share-point style collaboration space where users can create, share, and work on documents as well as start discussions, upload multi-media files and manage content. Highly customizable content, membership control, discussion board and basic documents.	

Inward	Share ideas/ team collaboration/knowledge collection Tacit to explicit repository Collaborative authoring of documents and as a forum for proposing ideas for new projects Internal brainstorming Create meeting agendas, post training videos for new hires Creating presentations Discussion archive / emergent, accumulative dynamic body of knowledge
Outward	External members can be invited to group Provides remote access to group documentation / group knowlege
Blogs (Web-Logging)	
Abbreviated from 'web log' - web-based journal authored by one or multiple writers, posts appear in reverse chronological order. Blogs serve as a platform to articulate thoughts, feelings, ideas, observations on issues of relevance to them - referred to as “posts”. Others can contribute, responding to posts as comments. Unlike Wiki’s there are typically tighter controls on authorship and who can contribute to the posts. Topic specific; topical / current content; can be journal or diarized in style and format; akin to newspaper or magazine articles in length and style	
Inward	• spark conversation/debate • build internal “community of interest” / group of “followers” • involve staff & utilise knowledge • report back from event/conference • opportunity for real conversation and feedback
Outward	• Spark conversation/debate • Build community • Professional interest blog • Collaborative project log • Resources and info & share experiences • Opportunity for very specific topic discussions and feedback
RSS Feeds (Really Simple Syndication)	
RSS enables blogs and podcasting, enhances social wikis and social networking applications and provides a channel for subscribing to content sharing common social tags. In simple terms RRS allows users to manage thier content into usable and is similar in function to a “bookmarks” or “favorites” folder on an internet browser.	
Application	* allows information providers to syndicate their content * enables visibility of content to increase * can spread multi-media files as well * compresses information gathering time

4 CASE EXAMPLES - SOCIAL SOFTWARE & ENGINEERING FIRMS

In order to highlight further the applicability of Enterprise 2.0 tools in engineering and industrial environments three publicly available case studies have been summarized to highlight the feasibility of implementing SMT applications in an engineering and industrial context. The case studies have been specifically selected to demonstrate that despite some of the more obvious perceived barriers such as lack of resources, security concerns or intellectual property issues SMT’s can be utilized to achieve a variety of knowledge management related aims. The first organization (Lockheed-Martin) demonstrates the utility and value of adopting a holistic approach to the implementation and use of E2.0 for innovation and new product development. The second (Pfizer) is used to demonstrate the feasibility of social software in IP rich environments where concerns surrounding information security are salient. The third (Burns Engineering) effectively highlights the cost effective nature of social software and the real benefits it can provide for small-medium engineering enterprises.

4.1 Lockheed-Martin

Arguably one of the more successful and celebrated attempts to adopt SMTs into an organization Lockheed Martin (LM) has invested significant amounts of time and resources into the development of a customized E2.0 application

(UNITY). Lockheed Martin is a Global Aerospace and Defense Company, with over 140 000 employees operating out of 1000 facilities across 75 countries [29]. The main motivation behind the introduction of Unity centered on knowledge management; LM was concerned about how to capture the knowledge of a retiring generation, with 50% of its workforce eligible to retire in the next 5-10 years [30]. This outflow of talent raises key concerns about how to uncover the tacit knowledge of these employees. Additionally, from a knowledge management perspective LM represents a very complex environment due to the highly diverse and often classified projects that they are engaged in. As such, determining a way to share silo'd information was also important for collaboration and knowledge sharing [31]. Additional drivers for LM to begin investing of social software included a concern about the "clogging" of systems by email, PowerPoint presentations and meetings and the need to connect a large, geographically dispersed workforce [32]. LM's approach to the use of social software has been holistic, and mimics some of the functionality present within publicly available tools such as Facebook.

The introduction of SMT at LM is a prime example of how social media technologies grow from grass-roots level initiatives. Starting with an 8K pilot project, LM built the basic Unity platform in 2007 leveraging their existing use of MS SharePoint and Active Directory 2003 [33]. LM's engineers integrated social media technologies such as blogs, wikis, RSS feeds, personal and group spaces and forums at a later date to enhance collaboration capability. The adoption of Unity at LM has grown virally since its introduction as a beta pilot in 2007, and now has over 4000 personal spaces [33], and 20'000 of an eligible 35'000 workers in the IS&GS division contribute content. LM attributes positive effects such as innovation, efficiency and productivity savings from searching for information, collaboration by allowing input and transparency from a geographically diverse set of users [32] and improved business agility to the introduction of Unity [34]. The organization has also reports that the introduction of Unity has helped alleviate some of its concerns surrounding the drain of talent and knowledge due to improved employee retention at a time when the company is facing a large number of retirements [35]. Additionally, younger employees pre-conditioned to the use of Web 2.0 in their social lives look favorably on a company using them internally [29]. Another unexpected benefit experienced by LM since the introduction of Unity is the interest that they have received from business partners and clients who consider LM to be a thought leader in SMT [36].

Introducing SMT into the organization presented LM with challenges that included how to embed social media applications into the day to day activities of employees and how to ensure data security [33]. In terms of security, LM has created regulations which oblige users to enter their personal information when posting; anonymity is not permitted and content can be flagged if inappropriate [35]. Additionally, due to the sensitive nature of some of their work, some documents are locked with access provided only to authorized users. To continue to enhance knowledge management throughout the organization and make Unity a tool that employees could easily understand and contribute to, LM introduced a "Collaboration playbook" that is a compilation of best practices of how and when to use SMT [33]. Interestingly, LM found that most of the contributors to their blogs were members of their workforce over 40. This is perhaps explained by more experienced employees possessing more knowledge to contribute and highlights that the key success factor in adopting SMT did not revolve around age, but rather around having "appropriate tools, motivation, and having something worthwhile to share." [37].

A key learning from the LM case is that it highlights the feasibility and value of SMT use in an organization with a diverse range of interested stakeholders (e.g. Defence clients, specialist teams, contractors) and the obvious security and intellectual property concerns that would be associated with being one of the world's largest Defence contractors. Summarized in Table 2.0 are the core aims, tools, realized outcomes and key learnings documented by LM in their experience with SMT's.

4.2 Pfizer

Pfizer is an excellent example of an organization located within an industry notorious for its aggressive protection of its intellectual property [38] using SMT for the explicitly stated aim of improving collaboration and developing new ideas. Pfizer invests heavily in Research and Development (R&D) and in 2008 spent approximately 15% of its revenue (approximately $7.5B U.S) on R&D efforts. From a return on investment perspective, any efficiency in the R&D process could have a huge impact on the bottom line and could expedite the introduction of potentially life-saving products to market [39].

However, similar to Lockheed Martin' experience Pfizer's E2.0 journey did not begin from an executive level mandate for organisational efficiencies, but was another user driven initiative triggered with the desire of one employee to improve collaboration and communication with colleagues [40]. Initially a blog was launched, open to all employees, followed closely by another employee driven initiative, a wiki using open-source software. The idea, initiated at the "grassroots level" is now part of the Pfizer IT ecosystem [41]. As an interesting technological aside, Pfizer's introduction to SMT started with the use of open source technologies; their blog began with the use of Drupal, an open source web content management application that provides users the ability to create both blogs and profiles to manage web content, Pfizerpedia began with MediaWiki and Scuttle was the open source software introduced for social bookmarking [42]. These initiatives proved to be a catalyst for Pfizer, which later established an E2.0 website (potentially termed Pfacebook after the existing social networking application) and continues to launch a range of SMT tools (See Table 3.0 below).

Table 2.0 Lockheed Martin

Aim	Core Tools	Realized Outcomes	Challenges & Key Learnings
Connect talented experts Build capacity to deliver complex integrated solutions Build collective intelligence Transfer knowledge from experienced employees Reduce noise generated by email, meetings & powerpoint tools	Custom In-house suite of SMT tools - UNITY Windows SharePoint Services Google (search engine) NewsGator (feeds, broadcast communications) Mash-ups (combinations of numerous applications) Social bookmarking tool (uBookmark)	Development of a social computing ecosystem Increased productivity from improved searching capability and rapid knowledge exchange Increased skills, knowledge and activity visibility	Address "*what's in it for me?*" Provide a user experience employees will love An effective enterprise search tool is critical Balance the "need to know" vs the "need to share" Use of filters and user-assignable taxonomies can help manage sensitive information Develop a "collaboration playbook"

Table 3.0 Pfizer

Aim	Core Tools	Realized Outcomes	Challenges & Key Learnings
Connecting geographical dispersed groups NPD, idea generation Improved collaboration Develop / enhance weak ties between tight research groups	Pfizerpedia (wiki) Pfacebook (SNT) RSS feeds (R&D employees) Blogs Event podcasts & broadcasts	Company wide adoption from an initial blog pilot project 13'000 users of Pfizerpedia worldwide within 1yr Significantly reduced e-mail traffic Initial low cost pilot projects	Allow E2.0 tools and use to spread "virally" Employees need to want it and see the value in it Understand the user's perspective and put them at the centre of the design Development of an E2.0 lab for testing - continue evolving

The introduction of Microsoft's SharePoint into the Pfizer IT environment has grown to reach 41 000 users [42]. SharePoint is used in conjunction with Microsoft's OneNote and handles operational content and work in process documents. To date, 1.3 Million documents have been migrated from 8 legacy systems into what has been termed the Enterprise Collaboration Framework (ECF) [43]. RSS feeds and social bookmarking are also part of the initiative to enable employee's to "pull" relevant data rather than rely on data that they may not need being pushed to their inboxes via email [44]. Pfizerpedia has grown to include R&D information, directories, discussion groups and databases [45]. Other successful examples include a wiki allowing developers to enter source code into a repository allowing the company to better manage proprietary information [42].

The success of Pfizer's launch into the E2.0 realm has provided numerous benefits for the organization. The technologies employed provide a platform for creating documentation, becoming a "repository for organizational memory" [46] while eliminating unnecessary and overwhelming emails. Pfizerpedia also allows Pfizer employees to unlock informational silo's, allowing employee's globally to both get information and also promote personal information and team projects. The information gained through the use of SMT has in some instances prevented redundancy in research efforts and funding, allowing Pfizer to maximize the return of research and development efforts [40].

The challenge of introducing SMT at Pfizer continues to be the need to balance the desire to enhance

collaboration, conform to regulations, and to protect their rich IP environment [46]. Many organizations struggle with the introduction of SMT technologies for fear of losing control of information and increased security risks, [47] but Pfizer has succeeded by introducing appropriate security measures while encouraging the technology adoption using a bottom up approach. Pfizer has also ensured that Pfizerpedia is located behind the company's firewall. Anything posted to the pages may be seen outside of the organization and employees have been made aware of this risk and must comply with strong governance and usage policies which have been introduced. Pfizer also uses moderators who patrol Pfizerpedia for inappropriate content. [43], [48].

An early adopter of E2.0 technologies, Pfizer provides an excellent example of how technology adoption can spread virally. Pfizer attributes the success of the wiki to the relevance that it provided to its employees and letting the use of the technologies grow without management interference [49]. By lowering the barrier to participation (the original blog allowed anyone in the organization to create content) [41], acceptance of Pfizerpedia has increased 400% since 2007 [48] with an average of 12000 unique visitors each month and 2500 individual contributors [46]. Interestingly both large organizations (LM & Pfizer) cite a reduction in e-mail traffic as a significant productivity gain as a result of SMT adoption indicating a number of peripheral flow-on benefits beyond those associated with improved collaboration and knowledge transfer [30],[43].

4.3 Burns Engineering

The case of Burns Engineering (BE) highlights the utility and scalability of SMTs in their ability to provide cost effective communication technologies to organizations with minimal resources. A small engineering and manufacturing firm BE uses social software predominantly as a marketing tool, prospecting for new customers while maintaining an on-going dialogue with existing clients. As an SME (Small-Medium-Enterprise) Burns Engineering is able to maintain an extensive network of contacts and sustain a frequent, timely dialogue with a range of stakeholders critical to the success of the business using a small number of E2.0 applications [50].

Introducing SMT into their technology landscape was a decision that was developed based on Burns' annual marketing plan. Building an online community with various stakeholders is now a mechanism for BE to facilitate deeper communications with customers and prospects in order to position products and services into the context of actual needs. Burns Engineering believes that the dialogue created via SMT technologies enables customers and suppliers to have transparent and authentic interactions with the company, providing them with a strategic differentiator in a mature industry. Among the tools used to collaborate with their online community, Burns Engineering uses a blog to discuss topics of interest and notify customers of early product announcements or service messages, customers can use the available RSS feed to receive updates. Also employed is the use of an online sensor configuration tool to allow customers to customize drawings to receive automatic quotes and online tracking systems to check the status of orders. BE has used cost effective methods to enhance communications, *Constant Contact* is used for email blasts, a *Twitter TME* community is being deployed, and to encourage feedback Burns has engaged with *PollDaddy* to survey customers.

Importantly the use of E2.0 applications to achieve all this means minimal investment in terms of time, finance and energy. In contrast to the previous two case examples BE demonstrates the use of social software to improve collaboration and information exchange with external stakeholders such as clients, subject experts and regulatory agencies without significant resources available to large multi-national corporations.

Table 4.0 Burns Engineering

Aim	Core Tools	Realized Outcomes	Challenges & Key Learnings
Cost effective technologies to leverage strategic plans To achieve the optimum on-line / off-line marketing mix	Blog - Wordpress Twitter Client Polling Software Linked-In Wikipedia	Customer engagement Rich, regular client communication Cost effective technological solution to solving users needs	Get on board...it's happening with or without you E2.0 should not stand alone Transparency and authenticity are a key outcome - are you ready for this?

These three case studies clearly highlight that regardless of core business, size, resource availability, customer-base or stakeholder profile SMTs can provide a useful tool for encouraging knowledge transfer and increased collaboration within and beyond organizational boundaries. An essential point however, evident in all three examples is that the type, functionality and use of E2.0 technology should be derived from a recognized need within the user community. The following discussion will briefly consider some additional issues that may have to

be addressed before adopting SMTs and provides an implementation plan for those organizations wishing to maximize the value of E2.0 technology.

5 DISCUSSION

The adoption of E2.0 technologies into an enterprise setting represents a number of significant advantages for organizations looking to manage large amounts of tacit information held within potentially segmented components of the organization. The nature of new generation E2.0 technologies facilitate and encourage interaction by acting as boundary spanning mechanisms that may complement an organization's existing ICT architecture by linking individuals and potentially disparate groups. This paper demonstrates that the introduction of E2.0 offers engineering organizations three major benefits in relation to achieving knowledge management goals.

The first major advantage is that E2.0 can help management & technical personnel overcome complex issues & problems by acting as an effective boundary spanning mechanism between otherwise disconnected sources of insight and knowledge. All of the case examples indicate positive results from the creation and sharing of knowledge within the enterprise, allowing organizations to leverage the expertise of employees with different skill sets in various geographic locations. Side benefits of the introduction of SMT at LM included greater employee engagement with senior members of the workforce, and the development of a competitive advantage in new talent acquisition. The case examples all indicate that the collaborative and interactive characteristics of E2.0 technologies have provided the organizations with increased capacity to share information to facilitate problem solving, reduce duplication of effort and increase business agility.

The second major benefit offered by E2.0 is its flexibility, with a number of alternatives suitable for a range of objectives depending on the nature of the organization, the capabilities of its personnel and desired outcomes. The case examples illustrate how complex engineering organizations can increase their capacity to accumulate and manage knowledge through the introduction of technologies that facilitate process improvement based on the storage and management of information. As noted, LM was driven to use SMT to improve the management of organizational information through reducing the load of email traffic that was clogging the system. Pfizer's introduction of SMT resulted in the development of a wiki repository used to manage proprietary information in a collaborative publishing approach, and BE uses SMT to manage knowledge obtained from customers in order to provide customized drawings and automated quotes, adding efficiencies and productivity improvements to existing processes. Importantly these examples illustrate that engineering organizations can effectively implement E2.0 technologies to manage and store complex and highly sensitive information

The third benefit from an operational perspective is the scalability of E2.0 applications, able to respond equally effectively to the requirements of the user and of the enterprise. The scalability of E2.0 technology adoption is apparent in the Pfizer example: from a user perspective 41 000 employees at Pfizer participate in social networking applications, while there are approximately 2500 contributors. This illustrates that employees can participate on the periphery or can actively contribute content. From an organizational perspective, BE provides us an example of how an SME's can tailor the use of E2.0 to their available resources and collaboration requirements through the use of cost effective applications. Through these examples of user adoption and enterprise implementation the importance of scalability is highlighted, allowing an organization to adopt a policy of incremental growth and technology investment as dictated by user uptake.

5.1 Implementation issues

In addition to the three major advantages discussed above, the case studies highlight a number of challenges that should be addressed in order to introduce and implement these types of technologies effectively. For example, complex engineering environments rely on the collaborative input from workers in various roles, some of whom have frequent access to computers and other ICT devices, while others may have limited or no access. Complicating this issue further is the matter of technology access granted to contractors and outsourced personnel. The continued adoption of portable computing devices and the capability of mobile phones may help to alleviate this issue, but will also put increased pressures on IT security. Given the significant roles played by employees at all levels and classifications, a number of strategies must be considered to overcome both the availability and security barrier.

A key issue pertaining to employee engagement that differentiates SMT applications as compared to conventional IT is the typical process of implementation into an organization[51]. McGrath and Krackhart [52] discuss a network diffusion model appropriate for the adoption of E2.0 tools in a knowledge management application. They suggest that in instances where a potentially controversial change is proposed (e.g. the adoption of an SMT) success comes from piloting the innovation at the periphery of the organization therefore reducing its threat level to non-adopters and allows the innovation to gain momentum before being exposed to organizational elements that may close it down prematurely. Organizations such as Lockheed, BT, Pfizer and Morgan Stanley all used a pilot or viral approach to deploying SMT into their work environments. Employees were encouraged to explore the applications for themselves which allowed the natural benefits of the SMT to diffuse through interested users.

Another important issue for organizations to consider in implementing SMT is the technical skill of employees. While in many organizations the use of technology is embedded in the day-to-day work of employees, the introduction of SMTs may require additional training for those unfamiliar with the new technologies. As illustrated in the LM case study, a collaborative playbook was introduced to the organization that captured and communicated lessons-learned from the introduction of the technology and allowed the organization to collectively adapt to the E2.0 experience. In order for an SMT to have its intended collaboration benefits, attention must be given to those employees who may lack the technological savvy to adopt the tools virally. Therefore, the way in which E2.0 is incorporated into the work process needs to reflect the levels of ICT literacy within the group and the structural capacity of the organization to absorb this technology type into their everyday functionality. A related issue concerns the awareness and acceptance of those in the group as to the potential of E2.0 tools to significantly improve the chances of a successful KM outcome. Tools such as Facebook and MySpace typically face media scrutiny in relation to workplace productivity and child endangerment [24]. While largely irrelevant when considering the use of these tools in a KM context it is possible that some within the organization will be both unfamiliar and uncomfortable with Web 2.0 in general. Therefore the way in which Web 2.0 is incorporated into the negotiation work process needs to reflect the levels of E2.0 awareness and acceptance within the group.

Along with clearly articulating the desired outcomes of adopting SMT, another critical factor is deciding whether to use existing, publicly available applications (e.g. Google Wave) or whether to invest in the development of an in-house bespoke application (e.g. UNITY). A review of the three case examples suggests the larger the organization and the more complex the desired outcomes, the more likely you are to consider the development of an in-house product. However an alternative approach adopted by British Telecom (BT) was to adopt a “churn’ strategy, purchasing a stream of cost effective beta products to pilot and measure user uptake based on viral marketing approaches - in simple terms, “*throwing stuff at the wall and see what sticks*” [52]. Importantly, this highlights that each organization should assess their strategic goals in order to come up with a solution that meets specific technology needs, support requirements and budgets prior to considering what technologies are suitable.

While the three case studies all offer successful examples of the introduction of new technology into an organization, it is not solely the introduction of Enterprise 2.0 applications that drive collaborative success. Rather, organizations should take a holistic approach considering more than just the technological tools, but also how these tools change the way people work on a day-to-day basis. This reflects the importance of having a supportive organizational culture and management buy-in, which McAfee [51] identifies as key factors in the success of SMT. McAfee’s observation about the importance of culture is echoed by Klinc et. al, [54] who observe that organizational culture is one of the biggest barriers an organization faces in introducing SMT. It is evident in the cases that management supported the SMT initiatives, participated in them and allowed them to grow without too much bureaucratic interruption. The open, horizontal and transparent nature of Enterprise 2.0 technologies dictate a change in organizations characterized by rigid management [55]. Consequently organizations considering the introduction of Enterprise 2.0 applications to break down informational silo’s must be prepared to give up some managerial control in order to allow the technologies to be adopted from a grass-root level.

In addition to the learning identified in each of the case examples some simple steps that organizations may wish to follow include:

1. Clearly articulate your intent in the adoption of E2.0 technologies
2. Review and identify potential applications compatible with the desired intent (e.g. generative aims versus documentive content management aims)
3. Review existing organizational practice to identify potential barriers, revise policy to suit
4. Develop the application with the user firmly in mind, clearly highlighting what’s in it for them and the value of their involvement
5. Pilot the use of the application within a single group without mandating how or why it should be used
6. Adopt a viral diffusion model to build user base dictated by interest and desire to be involved.

6 CONCLUSION

In considering the difficulties faced by engineering organizations in encouraging and facilitating collaboration across occupational tribes this paper has achieved a number of outcomes. In the first instance it is has reflected on the abilities of an emerging technology to act as a boundary spanning mechanism between otherwise disconnected groups. At its most fundamental, this paper acts as a primer for those seeking to gain an understanding of the design, functionality and utility of a suite of software tools generically termed Web 2.0 or Enterprise 2.0. Further, the utility of these tools in a complex technical environment to achieve knowledge management (KM) outcomes has been considered. Situating these tools in a KM context demonstrates that effective use of these tools can help improve the extraction and utilization of tacit knowledge within organizations - particularly in those where the potential for information silos is high (e.g. where strong departmental and functional boundaries exist, hindering co-operation and collaboration). Engineering and industrial contexts have been well documented for the presence of highly cohesive groups based around functional or role orientations [1]. While

highly cohesive groups are potentially advantageous they are also often correlated with the emergence of knowledge and information silos based around those same functional or occupational clusters. Consequently an essential challenge for organizations wishing to overcome informational silos is to implement mechanisms that facilitate, encourage and sustain interactions between otherwise disconnected groups. It is intended that this paper be an essential starting point for any complex organization looking at the use of new generation technologies such as Enterprise 2.0 for the explicit aim of connecting otherwise disparate and isolated groups.

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